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Age, growth, mortality, and population characteristics of the red snapper (*Lutjanus malabaricus*) in the Timor Sea waters, Indonesia

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Abstract. *Herwaty S, Mallawa A, Najamuddin, Zainuddin M. 2023. Age, growth, mortality, and population characteristics of the red snapper (*Lutjanus malabaricus*) in the Timor Sea waters, Indonesia. Biodiversitas 24: 2217-2224.* Red snapper (*Lutjanus malabaricus* Bloch & Schneider 1801) is a fishery resource with export commodities, high market demand is suspected of causing overfishing and a decrease in stocks, thus threatening its sustainability. This study aims to analyze the red snapper's age, growth, mortality, and population characteristics. Fish samples were collected at the Oeba Fish Landing Base Kupang from April to June 2020. The data analysis were as follows: the descriptively analyzed size structure, age group using the Bhattacharya method, growth parameter values ($L\infty$ and K) based on the von Bertalanffy equation, and natural mortality using the Pauly and Y/R using the Beverton and Holt methods. The results of the red snapper observation are as follows: the smallest size at 12.8 cm (FL), the largest size at 72.8 cm (FL), the average length at 42.03 cm (FL) ± 16.03, the growth parameter value ($L\infty$)=99.40 cm (FL), (K)=0.51 $year^{-1}$, t_0=-0.23018 $year^{-1}$, the population consisted of two and three age groups, the total mortality value (Z) 1.98 $year^{-1}$, natural mortality (M) 0.84 $year^{-1}$, fishing mortality (F) 1.14 $year^{-1}$, and exploitation rate (E) 0.58 $year^{-1}$. The actual Y/R value was 0.049, and the relative Y/R was 0.060 grams $recruit^{-}$ $year^{-1}$. The fishing mortality is higher than the natural mortality value; a high exploitation value (E>0.5) indicates that over-exploitation and stock conditions are unhealthy. The results of this study can be used as a reference in managing red snapper resources in the future.

Keywords: Population, dynamics, snapper, exploitation, stock

Abbreviation: FL: Fork length; $L\infty$: Asymptotic length; K: The growth coefficient; Z: Total mortality; M: Natural mortality; F: Fishing mortality; E: Exploitation rate; Y/R: Yield per recruitment

INTRODUCTION

Indonesia has a high biodiversity of demersal fish, which can be observed from the multispecies caught (Wibisono et al. 2019), the world's second-largest producer of snapper and grouper (Cawthorn and Mariani 2017), contributes 36% of global catch productions (Amorim et al. 2020). One of them is the fish red snapper (*Lutjanus malabaricus* Bloch & Schneider 1801). Red snapper is a demersal fish species from the Lutjanidae family that lives near the bottom of inshore and offshore waters and is caught at depths greater than 50 m (Wibisono et al. 2020). This fish has a reasonably long life and can reach 20 years, with relatively slow growth and low natural mortality (Zamroni et al. 2021). Furthermore, different habitats (Herwaty et al. 2021), changes in temperature (Mazumder et al. 2016), and other water conditions can affect their developmental phase (Heino 2014) and their morphology (Soliman et al. 2018). One of the waters in Indonesia that is suitable for the *L. malabaricus* habitat is the Timor Sea waters, East Nusa Tenggara Province. This condition is caused geographically. The waters of the Timor Sea border Australian waters; most of these waters are part of the Sahul shallows, so various deep-sea fish species occupy this habitat (Sadhotomo and Suprapto 2013). This fishery resource is important (Pakro et al. 2020) because it is a commodity with high economic value and export quality (Halim et al. 2020). Fishing gear commonly used to catch snappers and other demersal fishes are handlines, long bottom lines, and others.

One of the main problems facing fishery resources in the Timor Sea is the depletion of cross-border fishery stocks, especially snapper. This condition is caused by fishing practices and unsustainable management of the fishing industry, including over-exploitation, destructive fishing (Ramm 2014), and Illegal, unreported, and unregulated (IUU) fishing activities (Wibisono et al. 2020). The decreasing stocks of marine fish populations occur almost all over the world, including in Southeast Asia (Halim et al. 2022). Furthermore, global inventories will continue to decline (Asiedu et al. 2022) due to high market demand, especially in low- and middle-income countries (Hasselberg et al. 2020). This condition encourages fishermen to catch fish intensively throughout the year without regard to its sustainability (Bawole et al. 2017). On the other hand, FAO states that utilizing fish resources must be accompanied by management efforts, including using environmentally friendly fishing gear (Ramm 2014; Fachry et al. 2021; Daris et al. 2022) so that the fish resources remain sustainable (Dimarchopoulou et al. 2021).

In managing red snapper resources, data and information are needed to relate to biological aspects, population dynamics, stock conditions, and several related sources. Still, the lack of information on fish resources makes it almost impossible to develop sustainable fish management. Besides, there is practically no data on Snapper fisheries related to illegal, unreported, and unregulated (IUU) fishing activities, which seem to be a severe problem.

Several studies on *L. malabaricus* have been conducted in many locations. Fish population parameter of red snapper (*L. malabaricus*) in the South China Sea (Nurulludin et al. 2019), Size structure and gonad maturity of red snapper *L. malabaricus* in Pinrang waters, Makassar Strait, South Sulawesi, Indonesia (Rapi et al. 2020) and Life history and length base spawning potential ratio (LBSPR) of Malabar snapper *L. malabaricus* in western of South Sulawesi, Indonesia (Ernawati and Budiarti 2020), but so far information related to the dynamics population of *L. malabaricus* in the Timor Sea is lacking, while the results of research by Ramm 2014. was reported that status the biology of *L. malabaricus* in the waters of the Timor Sea is moderately exploited. Based on the description above, studying the population characteristics of *L. malabaricus* in the Timor Sea, East Nusa Tenggara Province, is essential. This study aims to analyze the age, growth, mortality, and population characteristics of *L. malabaricus* in the Timor Sea waters.

MATERIALS AND METHODS

Study area

The sampling and measurements were conducted at the Oeba Fish Landing Base, Kupang City, East Nusa Tenggara Province, Indonesia (coordinates 10º09'13.3"S 123º35'30.9"E). This study's materials and types of tools include red snapper (*L. malabaricus*) stationery, fish measuring instruments, cameras, computers, and software (Ms excel 2010 and FISAT II). The research location is presented in Figure 1, and the fish sample is shown in Figure 2.

Data collection

Fish samples were obtained from the fishermen caught around the Timor Sea and landed their catch at the Oeba Kupang Fish Landing Base. The number of fish samples was 540 individuals. Fish sample measurements were conducted for three months (April-June). Samples in April were 197 individuals, 171 individuals in May, and 172 individuals in June. Fish samples were examined by measuring the fork length (FL) using a length-measuring device with an accuracy of 1 mm. Sampling was conducted once a week using a stratified random selection from the smallest to the largest size that could represent the entire sample groups. Furthermore, the fish caught are categorized as small (<30 cm), medium (30-50 cm), and large (>50 cm).

Figure 2. One of the samples of *Lutjanus malabaricus* was obtained from the catch of fishermen who landed fish at the Oeba Kupang Fish Landing Base, Kupang, Indonesia on Sunday, 17 May 2020

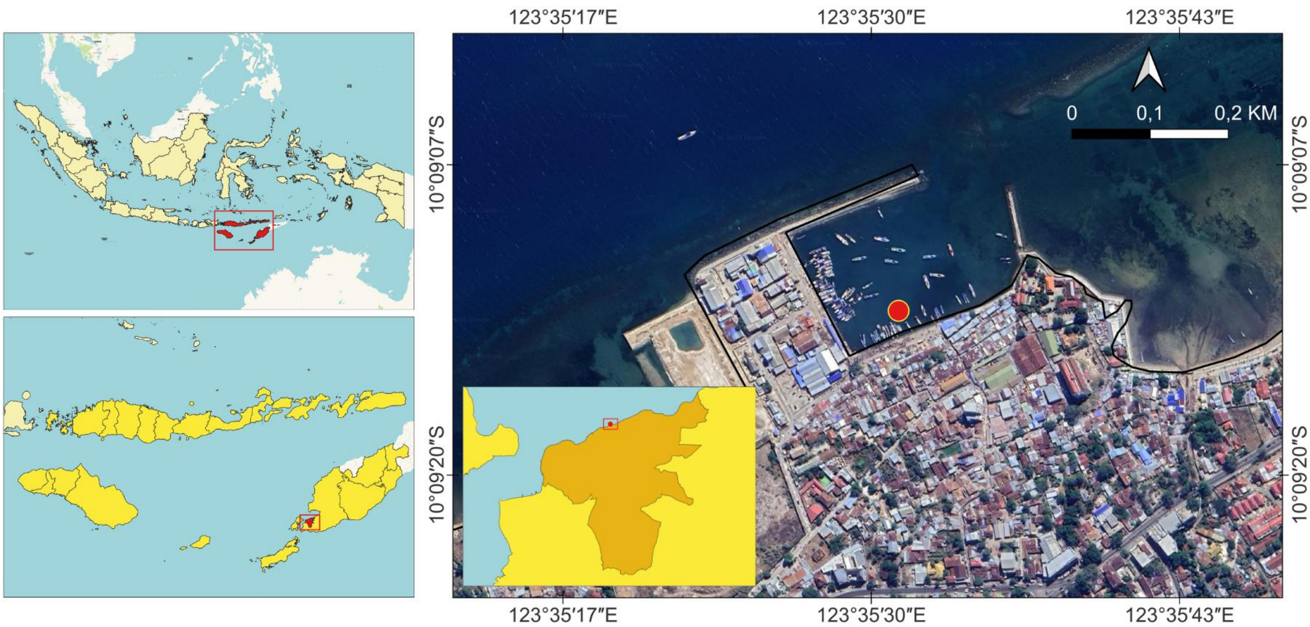

Figure 1. The sampling site location at the Oeba Fish Landing Base, Kupang City, East Nusa Tenggara Province, Indonesia

Size structure

The size structure of the fish was analyzed descriptively by displaying the percentage of long class intervals from the number of samples of the red snapper and shown in the histogram.

Age group

Age group estimation was carried out using length-frequency analysis which was processed using the Bhattacharya method and displayed in a column diagram (Pakro et al. 2020).

Growth parameters

The growth coefficient (*K*) and asymptotic length ($L\infty$) of fish were obtained based on the von Bertalanffy equation (Herwaty et al. 2021).

$$Lt = L\infty\left[1 - e^{-k(t-t_0)}\right]$$

Where *Lt* is the length at age *t*, $L\infty$ is the asymptotic length the fish reach if they grow indefinitely, and *K* is the growth coefficient.

The hypothetical age (in years) the fish would have had at zero length (t_0) was estimated by Pauly's empirical equation (1983). Where $L\infty$ and *K* are the growth parameters from the Von Bertalanffy function (Tirtadanu et al. 2018).

$$Log\ (-to) = -0.3922 - 0.2752\,(Log\ L\infty) - 1.038(Log\ K)$$

Estimating growth parameters $L\infty$ and *K* were calculated from length frequency distribution in catches using the Von Bertalanffy equation with the FISAT II software.

Mortality

The total mortality (*Z*) was estimated by the length converted catch curve in FISAT II software, with the Von Bertalanffy parameters (*K* and $L\infty$).

Total mortality was estimated from the slope of a catch curve with a negative slope based on the equation: (Viera 2018)

$$ln = \frac{Ni}{\Delta ti} = a \div b * t_i$$

Where: *Ni* is the number of fish in length class *i*, Δti is the time needed for the fish to grow through length class *i*, it is the age (or the relative age, computed with $t_0 = 0$) corresponding to the midlength of class *i*, and where *b* is the regression slope, and *a* is the intercept

The natural mortality (*M*) was estimated by Pauly's empirical formula (1980), calculated using the Von Bertalanffy parameters *K*, $L\infty$, and *T* as the annual mean of the water temperature (°C) (Mehanna 2017). The mean sea surface temperature taken is 29°C.

$$Log(M) = -0.0066 - 0.279\ log(L\infty) + 0.6543\ log(K) + 0.4634\ log(T)$$

Fishing mortality

The fishing mortality rate (*F*) was assumed using this equation: (Nurulludin et al. 2019).

$$F = Z - M$$

Exploitation rate

The exploitation rate (*E*) was determined by comparing the fishing mortality rate (*F*) with the total mortality rate (*Z*) (Kirubasankar et al. 2013).

$$E = F/Z$$

Yield per recruitment

Yield Per Recruitment (*Y/R*), obtained from the equations of Beverton and Holt (Sparre &Venema 1989) (Pakro et al. 2020).

$$Y/R = E.U^m\left[1 - \frac{3u}{1+m} + \frac{3u^2}{1+2m} + \frac{u^3}{1+3m}\right]$$

$$U = 1 - \frac{L_c}{L_\infty}$$

$$m = \frac{1-E}{M/K}$$

Where: *Lc* is the length of the fish at age *t*, *K* is the Coefficient of growth rate ($year^{-1}$), *Z* is the total mortality rate ($year^{-1}$), *M* is the death rate due to natural factors, and *E* is the Exploitation Rate ($year^{-1}$). All parameters are calculated using FISAT II software.

RESULTS AND DISCUSSION

Size structure

The number of *L. malabaricus* samples collected during the study was 540 individuals, with details as follows: the largest fish size was 72.8 cm (FL), the smallest size was 12.8 cm (FL), the class width was 6, the number of classes was 11, the class interval was 12.8-72.8 cm (FL), the average length was 42.03 cm (FL) ±16.03. The largest size caught was within the long class interval 30.8-35.8 cm (FL), with as many as 87 individuals (16%), and in the class interval 60.8-65.8cm (FL), as many as 81 individuals (15%). The size structure of *L. malabaricus* is presented in Figure 3.

Number of age groups (Cohort)

The length frequency distribution uses the Bhattacharya data sampling method for three months. The analysis of separating the age groups using the Bhattacharya method in the FISAT II program obtained the following results: the first sample (first month) consisted of two age groups. The mean in group I was 30 cm (FL) ± 7.33, and in group II was 57 cm (FL) ± 6.36. The second sample (second month) consisted of three age groups: the mean in group I was 28 cm (FL) ± 5.66, group II was 43 cm (FL) ± 6.15, and group III was 61±4.43 cm. Finally, the third sample (third month) consisted of two age groups: the mean in group I was 38 cm (FL) ± 7.97, and in group II was 59 cm (FL) ± 6.0. The composition of the fish frequency distribution of *L. malabaricus* is presented in Figure 4. Age groups, mean length, number of individuals, and separation index of *L. malabaricus* are shown in Table 1.

Population growth

Growth parameter analysis was carried out using the FISAT II software ELEFAN I program so that the values of K, L∞, and Rn (Goodness of fit) were obtained in Table 2. As a result, the growth rate of *L. malabaricus* is presented in Figure 5. From the length of the infinity (L∞) = 99.40, the growth rate (K) 0.51^{-1}, and the value of t_0 was -0.23018^{-1} could be obtained from the growth equation of Von Bertalanffy as follow:

$$Lt = 99.40\left[1 - e^{-0.51(t+0.23018)}\right]$$

Figure 6 shows the curve of the relationship between the age and length of *L. malabaricus* by that equation.

Mortality and exploitation

The calculation using Pauly's empirical formula, with the parameters including the values of the length of the infinity (L∞) = 99.40, the growth rate (K) 0.51^{-1}, the value of t_0 was -0.23018^{-1}, and the average temperature during the study so that the values obtained of Z, M, F, and E were presented in Table 3. The length converted catch curve is shown in Figure 7.

Yield per recruitment

The Y/R value using the Beverton and Holt equation calculation: the importance of the length of the infinity (L∞), Coefficient of growth rate (K), Natural mortality (M), fishing mortality (F), and exploitation rate (E), so that the relative Y/R value was 0.060 grams per recruit, and the actual Y/R value was 0.049 grams per recruit, while the values for E50, Emax, and E10 were 0.278, 0.421 and 0.355, respectively, were presented in Figure 8.

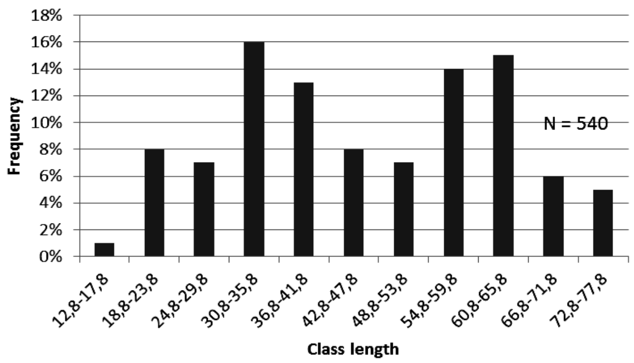

Figure 3. Percentage frequency of class length intervals of *Lutjanus malabaricus* in the Timor Sea waters, Indonesia

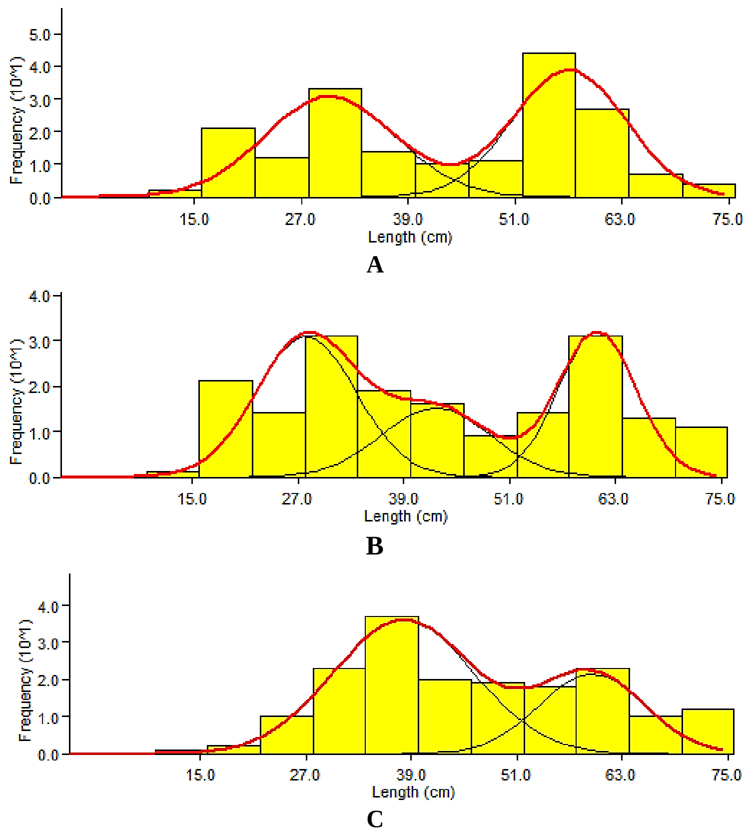

Figure 4. The composition of the fish frequency distribution of *Lutjanus malabaricus* in the Timor Sea waters. A. Sample 1, B. Sample 2, C. Sample 3

Table 1. Age groups, mean length, number of individuals, and separation index of *Lutjanus malabaricus* in the Timor Sea waters, Indonesia

Group	Mean (cm)	SD	Population	SI
Sample I (first month)				
I	30	7.33	94	n.a
II	57	6.36	103	2,70
Sample II (second month)				
I	28	5.66	73	n.a
II	43	6.15	39	2,17
III	61	4.43	59	2,32
Sample III (third month)				
I	38	7.97	119	n.a
II	59	6.0	53	2,32

Table 2. *L*, *K* and t_0 values of *Lutjanus malabaricus* in the Timor Sea waters, Indonesia

Parameters	Value
Asymptote Length, L∞ (cm)	99.40
Coefficient of growth rate, K(per year)	0.51
Rn (Goodness fit).	0.794
Theoretic age in fish length equal to null, t_0 (year)	-0.23018

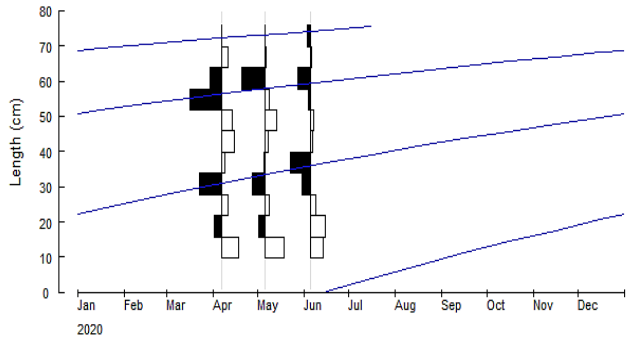

Figure 5. The growth rate of *Lutjanus malabaricus* in the Timor Sea waters, Indonesia

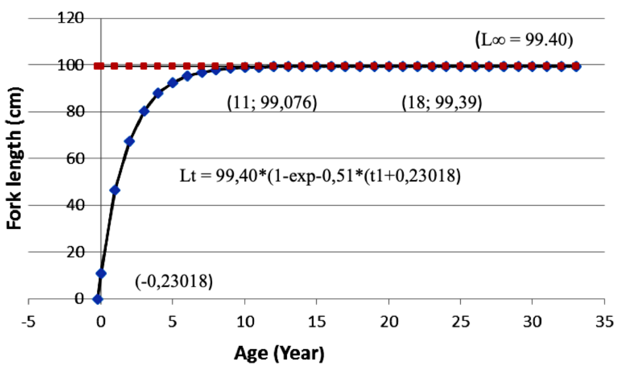

Figure 6. Von Bertalanffy's growth curve of *Lutjanus malabaricus* in the Timor Sea waters, Indonesia

Discussion

Snapper is a marine product with substantial value in all its geographical areas (Mehanna et al. 2017), including the Arafura and Timor Sea, which Australia geographically borders (Ramm 2014); this is a key species targeted in fisheries Coral Line in Australia (Campbell et al. 2021). In addition, previous studies have shown that there may be shared stocks of *L. malabaricus* that inhabit northern Australia (Sadhotomo and Suprapto 2013). However, existing conditions indicate that this fish resource continues to be exploited, thus reducing stock degradation. Therefore, knowledge and understanding are needed to manage this fish resource so that it can be sustainable.

The size distribution of *L. malabaricus* obtained during the study was similar to other locations. For example, research by Ernawati and Budiarti (2020) in western South Sulawesi revealed the size of *L. malabaricus* caught ranging from 12-81 cm, with an average length of 34.2 cm (±12.04). Another study reported the size caught in Pinrang waters, the Makassar Strait, South Sulawesi, ranging from 19.5-69.5 cm with dominant sizes of 39.5 cm and 69.5 cm (Rapi et al. 2020). Efendi's study et al. (2021) reported *L. malabaricus* caught in Saleh Bay in 2017 with an average length of 56.15 cm and in 2018-2019 with an average of 55 cm. While the study by Amorim et al. (2020) in the Java Sea reported that *L. malabaricus* caught in 2018 using dropline fishing gear had an average size of 42.5 cm, and using fishing gear varied by 41.3 cm. Differences influence the differences in fish size structure in fishing gear, fishing pressure (Tirtadanu et al. 2018), availability of food, the wider fishing area (Herwaty et al. 2021), and the time of sampling of fish.

While Rudd and Thorson (2017) stated that an increase in fishing mortality would be expected to decrease average length as more individuals were harvested. Therefore, only smaller individuals remained, which impacted the population size structure (Rumagia et al. 2021). In addition, differences in fish size in the study area are thought to be due to changes in *L. malabaricus* migration patterns during winter from Australian waters to warmer waters (Timor Sea waters) (Sadhotomo and Suprapto 2013). This migration is conducted to obtain suitable space and the availability of food for survival (Nurlita and Sanjayasari 2022), and this condition causes density (Stige et al. 2019) so that the sizes are more varied (Sadhotomo and Suprapto 2013). According to Sadhotomo and Suprapto (2013), the migration process is mainly from April-October.

Table 1 shows differences in the age groups and the mean values carried out for three times sampling (three months). The first and third sampling (first and third month) consisted of two age groups, while the second sample (second month) consisted of three age groups, this difference is influenced by sampling periods. The number of age groups was greater because the fish samples comprised small to large sizes, so they were more varied. Figure 4 shows two different age groups of three samples (three months). This indicates that the fish caught comprises young, pre-adult to adult fish, and the number of fellow fish species in the water is not necessarily the same. Furthermore, this difference may be influenced by water conditions, food availability, fish mortality by natural factors or fishing pressure (Silooy et al. 2021), the compositions, sampling period, etc. As a result, these factors caused the number of cohorts in water to be relative and dynamic. The length (FL) of the most undersized red snapper during the study was recorded at 12.8 cm, suspected to be less than one year old; the most extended recorded size was 72.8 cm, estimated to be approximately two years old.

Based on the Von Bertalanffy equation, the asymptotic length growth parameter ($L\infty$)=99.40 cm, growth coefficient (K)=0.51 per year, and t_0=-0.2301 per year. Figure 6 shows that the *L. malabaricus* in the Timor Sea, East Nusa Tenggara experienced relatively fast growth in the early stage (years I- IV). In the next stage, years V−X, its growth began to slow, and in years XI, it slowed down until it reached its asymptote length ($L\infty$=99.40). This asymptote length is estimated at 33 years; at 11 years, it is suspected to have a length of 99 cm, and at 18 years, it has a length of 99.39 cm. Meanwhile, Campbell et al. (2021) reported that female red snapper in Australia was 28.46 cm (1 year old) and 74.42 cm (35 years old), while males were 25.49 cm (1 year old) and 83.8 cm when they were 35 years. The results of Nurulludin's study et al. (2019) reported that red snapper in the waters of the South China Sea was estimated to reach an asymptotic length at the age of 36 years. Table 4 is an estimate of the growth parameters of *L. malabaricus* at different locations, which shows various values of von Bertalanffy growth parameters.

The growth coefficient is a barometer determining how fast a fish can reach its maximum length. Fish with a high growth coefficient generally have a shorter lifespan, whereas fish with a low coefficient tend to have a longer life. (Bintoro et al. 2020). Table 4 shows the growth rate of *L. malabaricus* in the Timor Sea has a higher value than in other areas. However, the results of another study on red snapper with different species in Alor waters, East Nusa Tenggara Province, obtained a higher growth coefficient rate, with a (K) value of 0.69 per year (Pakro et al. 2020). The value of the growth rate coefficient (K) of 0.51 per year explains that the red snapper population is growing relatively fast (K>0.5 per year), meaning this fish, in a few years, has reached asymptote length ($L\infty$).

Saha et al. (2018) stated that individuals from different *Lutjanus* (congeneric species) are as paraphyletic. They consist of one ancestral species and several descendant species, so differences in growth parameter values are thought to be due to differences in location, habitat, period sampling, number, and composition of samples taken during the study. According to Vieira (2018), this condition is caused by geographical area and fishing gear used. In addition, feeding availability, water quality, temperature, dissolved oxygen, age, gonadal maturity (Nurlita and Sanjayasari 2022), fishing season (Pakro et al. 2020), sex, disease (Wardani et al. 2021), water depth (Ramachandran et al. 2014), predation, and exploitation also affect growth rates (Ghosh et al. 2016).

Table 3. Z, M, F, and E values of *Lutjanus malabaricus* in the Timor Sea waters, Indonesia

Mortality value	Estimated value ($year^{-1}$)
Total mortality (Z)	1.98
Natural mortality (M)	0.84
Fishing mortality (F)	1.14
Exploitation rate (E)	0.58

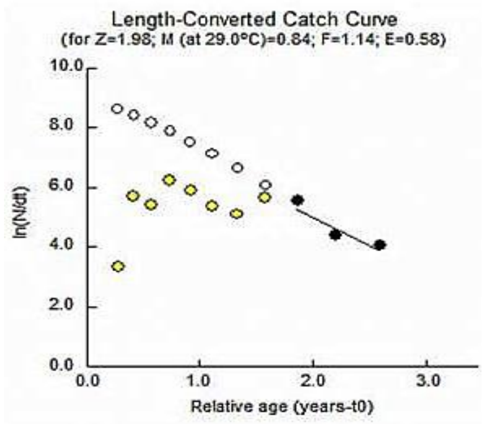

Figure 7. Length converted catch curve of *Lutjanus malabaricus* in the Timor Sea waters, Indonesia

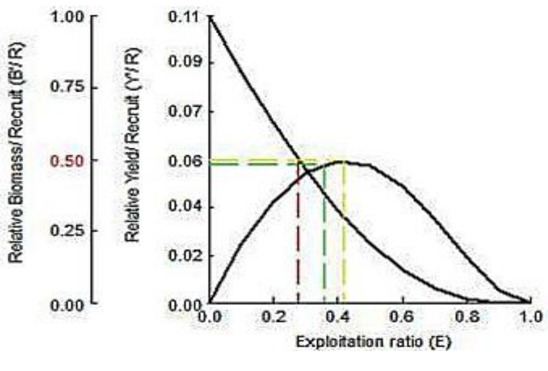

Figure 8. Model Relative Yield-per-Recruit (Y/R) Beverton & Holt of *Lutjanus malabaricus* in the Timor Sea waters, Indonesia

Table 4. Estimated growth parameters of *Lutjanus malabaricus* in different locations

Area	$L\infty$	K($year^{-1}$)	t_0($year^{-1}$)	References
Sinjai water, Indonesia	77.3 cm	0.293	- 0.34	Tirtadanu et al. (2018)
Timor and Arafura Sea	100 cm	0.30		Sadhotomo and Suprapto (2013)
Western South Sulawesi, Indonesia	73.98 cm	0.245	-0.5339	Ernawati and Budiarti (2020)
South China Sea	86.10 cm	0.21	-0.0235	Nurulludin et al. (2019)
Indonesia	84 cm	0.23		Peter et al. (2022)
Timor Sea waters	99.40	0.51	-0.2301	*The present study*

Table 3 illustrates that the fish mortality rate due to fishing (F=1.14 per year) is higher than its natural mortality (M= 0.84 per year). This condition indicates high exploitation, allegedly due to increased fishing by various fishing gear. As adults, fish form seasonal spawning aggregations, the ability of fishermen to predict, relocalize, and target dense aggregations into points of concentration even though population size decreases, making them vulnerable to exploitation (Robinson et al. 2014). The characteristics of the snapper in tropical waters are its relatively long life, low productivity, and vulnerability to overfishing. For example, individuals in an age group that is fully exploited, their predation rates decrease because the mortality rate due to fishing is higher than natural mortality (Pakro et al. 2020). While if long-lived species are caught before maturity (or gonadal maturity), it will impact fish stocks (Renán et al. 2015; Amorim et al. 2016). High fish mortality also occurred in the Timor and the Arafura Seas, with a value of M=0.27 per year and an F value of 1.14 per year (Sadhotomo and Suprapto 2013).

On the other hand, a high natural mortality rate occurred in Sinjai waters and its surroundings, with a value of M=0.47 per year and a mortality rate due to fishing F=0.25 per year (Tirtadanu et al. 2018). Stige et al. (2019) stated that natural mortality due to increased long-term predation rates of predator populations would impact the survival rate of juvenile fish and ultimately affect fish abundance. Differences in fish mortality in waters are thought to be influenced by differences in sampling time, sample size distribution, and water conditions. According to Nurulludin et al. (2019), this difference is affected by physical and chemical water conditions, food availability, age, disease, density, parasites, predator abundance, and water temperature (Santos et al. 2022)

The exploitation rate at E10 of 0.355 yearly produce a Y/R of 0.059. While at E50 of 0.278 yearly produces a Y/R of 0.052, and at Emax of 0.421 yearly produces a Y/R of 0.06. The exploitation rate at the study site was E=0.58 per year, indicating that the exploitation value has exceeded the maximum exploitation value (Emax), optimum (E50), and economic yield index (E10). The exploitation value E>0.5 indicates that there was an over-exploitation and the stock conditions are unhealthy. Conversely, if the value of the exploitation rate is E=0.5, then exploitation is running optimally, and stock is available (Tirtadanu et al. 2018). More severe management is needed in over-exploited conditions, such as limiting fishing efforts (trips), conservation, and recovering reef fish habitat. The Y/R value of *L. malabaricus* in the waters of the Timor Sea, East Nusa Tenggara, is not optimal. The actual Y/R is lower than the relative Y/R, meaning that adding new supplies to the stock is not running optimally. This condition is thought to be due to the high fishing by various fishing gear, causing excessive pressure (Mehanna et al. 2017). Therefore, scheduling the right time to catch fish at optimum sizes is necessary. In addition, catching young fish before spawning and gonad maturity causes reduced opportunities for additional new supplies (recruitment).

In conclusion, the number of *L. malabaricus* samples collected during the study was 540 individuals, comprised: the largest fish size was 72.8 cm (FL), the smallest size was 12.8 cm (FL), the class width was 6, the number of classes was 11, the class interval was 12.8-72.8 cm (FL), the average length was 42.03 cm (FL) ± 16.03. The largest size caught was within the long class interval 30.8-35.8 cm (FL) with 87 individuals (16%) and in the class interval 60.8-65.8 cm (FL) with 81 individuals (15%). These samples comprised two and three age groups: young, pre-adult, to adult fish. These samples have relatively fast growth, reaching their asymptotic length faster ($L\infty$). In addition, the fishing mortality rate was relatively high, presumably due to increasingly intensive fishing by fishermen using various fishing gear. The Y/ R was not optimal, where the actual Y/R was smaller than the relative Y/R. The exploitation level at the research location was E=0.58, indicating an exploitation value of E>0.5 (overfishing condition).

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